MASTER

XXXI

Year-to-year variations in rainfall totals

1. Introduction

For irrigation planning it is necessary to find a method of representing rainfall climate which gives not only the average value but also the expected variation about the average.

The simplest way of doing this for practical purposes was found to be the calculation of ten percentages, which, when multiplied by the average, gave ten sample rainfalls. These would give an estimate of the rainfall totals over ten years arranged in ascending, but not chronological, order.

2. Previous Work

Several years ago, this problem was solved by using 25 year rainfall records (1924-48) from 60 stations; these stations were selected from five main areas, Kent, Vale of Evesham, Somerset, Fen District and South Yorkshire, there being 12 stations in each area. The April to September months only were analysed and mean percentages were calculated for periods of 1, 2, 3, 4, 5 and 6 months. These sampling percentages were published in Table 8 of the M.A.F.F. Technical Bulletin No.4 (The Calculation of Irrigation Need).

3. Present Investigation

Because the previous investigation was restricted in area, in time and in range of rainfall averages, it was decided to check these figures using 12 well scattered stations with 50 year records (1910-59) and with a larger rainfall range. These were:-

Station	Annual Rainfall Average (1916-50) (in.)	Category	
Carlisle	32	North.	High Rainfall
Newcastle	28	North.	Low Rainfall
Haslingden (Lancs.)	57	North.	High Rainfall
Leyburn (Yorks.)	35	North.	High Rainfall
Lincoln	24	North.	Low Rainfall
Shrewsbury	26	North.	Low Rainfall
Treherbert (Glam.)	94	South.	High Rainfall
Oxford	26	South.	Low Rainfall
Thetford (Norfolk)	25	South.	Low Rainfall
Kennick (Devon)	44	South.	High Rainfall
Ringwood	33	South.	High Rainfall
Ashford (Kent)	29	South.	Low Rainfall

4. Comparison of Results

For each station the 6 month (April to September) rainfall total of each year was expressed as a percentage of the 50 year average. The required samples were then calculated by taking the mean of the 5 lowest percentages, the mean of the next 5 lowest and so on. The final figures were the mean taken over the 12 stations for each of the 10 samples.

This was repeated for 5, 4, 3, 2 and 1 month periods, taking into consideration each possible period of successive months within the summer period. i.e. April to August and May to September for the 5 month period and each month for the 1 month period.

The old and the new results are summarized in Table 1. The similarity is striking and confirms that the old published figures were thoroughly reliable for practical purposes.

5. Further Analysis

The 12 stations used in this analysis can be subdivided in 3 ways:- high rainfall and low rainfall, east and west, and north and south. The first two subdivisions are almost identical and neither of them reveal any appreciable differences; for example in the 6 month period:-

Sample	1	2	3	4	5	6	7	8	9	10
Low Rainfall	59½	72½	83½	91½	96½	103	108	116	124½	145
High Rainfall	61½	74½	82½	89½	96	102	109	115½	126½	143

There is a greater difference between the north and south groups, the southern group, as might be expected, being closer to the old figures, especially in regard to the lowest sample percentage.

The largest differences of all, however, occur when the different sequences of months are considered. There is a definite tendency for variations about the average to be greater in the later months of the summer season.

This suggests that the original simple table could be usefully amplified by separate tables for northern and southern areas and for the different sets of months. This has been done in Tables 2 and 3.

Table 4 shows the mean lowest percentage that has been recorded in the 50 years under review.

Table 5 shows a similar analysis for the winter six month period, October to March.

L. P. Smith

Agricultural Memorandum No. XXXI
Harrow.

July 1960

Table 1.

Sample Percentages of Rainfall Average

	1	2	3	4	5	6	7	8	9	10
6 Months										
Old	56	74	84	91½	97½	102½	108½	116	126	144
New	60½	73½	83	90½	96½	102½	108½	115½	125½	144
5 Months										
Old	54	72	82	90	97	102½	109	117½	129	147
New	59	72	81½	89	96	102½	109	117	127	147
4 Months										
Old	51	69	79	88½	96	102½	110	119	132	153
New	56	70	79½	87½	94½	102	109	118	130½	153
3 Months										
Old	47	66	77	86½	95	102½	110½	120½	135	160
New	51	66	77	85½	94	102	111	120	134	159½
2 Months										
Old	39	60	72	82	92	102	112	124	142	175
New	41½	60	71½	82	92	102	113	124	141	173
1 Month										
Old	20	41	59	73½	88½	103	118	135	158	204
New	22½	44½	60	74½	87	100	115½	133	157½	205½

Table 2

Sample percentages of Rainfall Average - Northern Areas

	1	2	3	4	5	6	7	8	9	10
(a) Six month period										
April - September	62½	74½	83½	91	97	101½	107½	115	123½	144
(b) Five month periods										
April-August	65	73½	82	89	95½	103	109	115½	124	143½
May-September	57	72½	80½	88½	96½	102½	108	116	129½	149
MEAN	61	73	81	89	96	103	108½	116	126½	146
(c) Four-month periods										
April - July	61½	76	82½	89	94½	100½	105½	114½	127	149
May - August	59	69	79½	87½	95½	103½	110	117	127½	151½
June - September	55	68	77	86	93½	101½	108	118½	135	157½
MEAN	58½	71	79½	87½	94½	102	108	116½	130	152½
(d) Three month periods										
April - June	55	68	77	86½	97	104	111	118	128½	155
May - July	55	68½	79	87½	93½	102	110	116½	131	157
June - August	54½	66	75	85	92	101½	110	120	134½	160
July - September	47½	64½	77½	84½	92½	100½	109½	121	138	164½
MEAN	53	67	77	86	94	102	110	119	133	159
(e) Two month periods										
April - May	50	63	72	79½	90	101	110½	122½	135½	176
May - June	48½	60½	71½	81½	92	102	113	123½	139½	168
June - July	44	64	76	85	91½	100	112½	121	138	168
July - August	40½	59½	74	85	94½	102	113½	124½	139½	167
August - September	36	59½	69½	80	91½	101	112½	124	146	180
MEAN	44	61½	72½	82	92	101	112½	123	139½	172
(f) Single months										
April	22½	46	64½	77	88	101	113½	129	155	203½
May	33	52	64	77	86½	96½	112½	130	152	196½
June	20½	43	58	73	89½	98	113	131½	159	214½
July	28	51	64½	79	90½	102	114½	129	150½	191
August	22½	48½	63½	75½	86	99	113½	133½	155½	202½
September	20½	41½	56½	70	82½	98	114½	134½	161½	220½
MEAN	24½	47	62	75	87	99	113½	131½	155½	205

Table 3

Sample percentages of Rainfall Averages - Southern Areas

	1	2	3	4	5	6	7	8	9	10
(a)										
Six month period										
April - September	58½	72½	82½	90	96	103½	109½	116	127½	144
(b)										
Five month periods										
April - August	60	75½	84	90	95½	102	108	116½	125	143½
May - September	55	67½	79½	88	96	103	110½	119	130½	151
MEAN	57½	71½	82	89	96	102½	109	117½	127½	147½
(c)										
Four month periods										
April - July	59	73½	81	88½	95½	100½	109½	117½	128	147
May - August	54	69	79½	88½	95½	102½	109	119	130½	152½
June - September	50	66	76	84	92½	102½	112	123½	134	159½
MEAN	54	69½	79	87	94½	102	110	120	131	153
(d)										
Three month periods										
April - June	54	71	80	86	97½	100	107	117½	134½	156½
May - July	52½	67½	77	84	94½	103½	113	122	134	152
June - August	46½	64	76½	86	92½	101½	111	121	134½	166
July - September	42½	61	72½	84½	95	103½	114½	124	138	164½
MEAN	49	66	76½	85	94	102	111½	121	135½	159½
(e)										
Two month periods										
April - May	46	62	73	82	90½	98	109½	123½	143½	172
May - June	44½	61½	73	80½	91	101½	112	123½	141½	171
June - July	37	58	70	81	93½	107	114½	125	140	174
July - August	35	57	71	86	96½	104	113½	124½	138½	174
August - September	35	52½	65½	78	90½	104	118½	130	146	180
MEAN	39½	58	70½	81½	92½	103	113½	125½	142	174
(f)										
Single months										
April	17	47	60	78	92	104	116½	134	157	194½
May	28	46	62½	75	88½	100	112	130	153½	204½
June	18½	38	55	69	82½	100	117	138½	167	214½
July	19½	40½	59	76	88½	102½	118½	136	158	201½
August	19½	43½	60½	71½	86	100	119½	135½	154½	209½
September	19½	40½	55	72	85	99½	116½	134	162½	215½
MEAN	20½	42½	59	73½	87	101	116½	134½	159	206½

Table 4

Lowest percentage of average rainfall in 50 years

	Northern Areas	Southern Areas	Mean
(a) Six months			
April - September	53	48	50½
(b) Five months			
April - August	57	48½	53
May - September	45	43	44
MEAN	51	46	48½
(c) Four months			
April - July	52½	44½	48½
May - August	50	44	47
June - September	44½	38½	41½
MEAN	49	42½	45½
(d) Three months			
April - June	47	45	46
May - July	48	36½	42
June - August	46	35	40½
July - September	34½	35½	35
MEAN	44	38	41
(e) Two months			
April - May	38	32½	35
May - June	37	31½	34
June - July	29	22½	26
July - August	31	24	27½
August - September	17½	24	20½
MEAN	30½	27	28½
(f) Single months			
April	12	8	10
May	20½	17½	19
June	5½	6½	6
July	12½	10½	11½
August	6½	4½	5½
September	9½	6	8
MEAN	11	9	10

Table 5

Sample percentages of Winter Rainfall Averages

	Lowest in 50 years	1	2	3	4	5	6	7	8	9	10
North	58	65	76	83½	90½	95	101	108	115½	123	142½
South	55	62½	75½	84	92	96½	101½	107½	115	124½	141
Low Rainfall	57	63	76	82½	90	94	100½	108½	116	126	143½
High Rainfall	56	64½	75½	85	92½	98	102	107	114	122	139½
MEAN	56½	64	75½	84	91	96	101	108	115	124	141½

G.1548/DEW/8/60/100